AVA Submission:

Response to the Draft Report by the Heat Stress Risk Assessment (HotStuff) Technical Reference Panel

1 March 2019

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AUSTRALIAN VETERINARY ASSOCIATION

About us

The Australian Veterinary Association (AVA) is the national organisation representing veterinarians in Australia. Our 9,500 members come from all fields within the veterinary profession. Clinical practitioners work with companion animals, horses, farm animals and wildlife. Government veterinarians work with our animal health, public health and biosecurity systems while other members work in industry for pharmaceutical and other commercial enterprises. We have members who work in research and teaching in a range of scientific disciplines. Veterinary students are also members of the AVA.

Executive Summary

1. The Australian Veterinary Association (AVA) supports recommendations 1-8 in the Draft Report of the Heat Stress Risk Assessment (HSRA) Technical Reference Panel. The panel's recommendations concur with those made by the AVA in our submission into the HSRA (HotStuff) Review, the full text of which can be read at the following link:

   http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/australian-veterinary-association.pdf.

   For the purpose of brevity, aspects on which there is concurrence are not repeated in this current submission.

2. A simplified Panting Score table using clear language is provided, to assist with training all workers along the export supply chain to recognise the various stages of heat stress in sheep.

3. The calculated heat stress threshold (HST) wet bulb temperature (WBT) for any class of sheep must be applied to the predicted *deck* WBT rather than predicted *ambient/bridge* WBT, as there is usually a 2-4°C rise in WBT across decks between ventilation inlets and outlets. As such, the temperature on deck where the sheep are contained will be 2-4°C higher than ambient/bridge WBT.

4. The acceptable duration of exposure to the HST for any class of sheep must be determined as soon as possible, beginning on voyages from March 2019, by monitoring ambient/bridge and deck WBTs and sheep panting scores using appropriate technology, across decks and across days.

5. Until such time that there is peer-reviewed evidence to indicate otherwise, the AVA recommends that sheep should never be exposed to HST 3, even for short periods. Sheep should not be exposed to HST 2 for more than 3 consecutive days where there is inadequate diurnal temperature variation to allow for respiratory rates to return to resting range at night (thermoneutral zone). Otherwise, sheep can start dying within 3 days of being exposed to continuously hot, humid weather, as heat load is cumulative. This duration of permissible exposure should be further reduced in the presence of other welfare imposts and/or co-morbidities, as these will further reduce the animals' ability to cope.

6. The panel's recommendations should be implemented by the government without delay for every future live export shipment.

This document is designed to be read in conjunction with the HSRA Technical Reference Panel's report and AVA's previous submission into the HSRA review.

Overall comments

Comment 1

The Australian Veterinary Association (AVA) supports recommendations 1-8 in the Draft Report of the Heat Stress Risk Assessment Technical Reference Panel (*HotStuff Panel* hereafter). The HotStuff Panel's recommendations concur with those made by the AVA in our submission into the HSRA (HotStuff) Review in October 2018.[1]

The AVA strongly supports the statement made by the HotStuff Panel that:

"*mortality is an insufficient indicator of animal health and welfare, given that animals may suffer and have reduced welfare without actually dying, and that mortality levels may represent the 'tip of the iceberg' in terms of impacts on animal welfare*"[2].

The HotStuff Panel broadly agrees with the AVA summary of the pathogenesis of heat stress in sheep (**Figure 1, following page**).

[1] Source: http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/australian-veterinary-association.pdf

[2] Source: https://haveyoursay.agriculture.gov.au/39528/documents/95066)

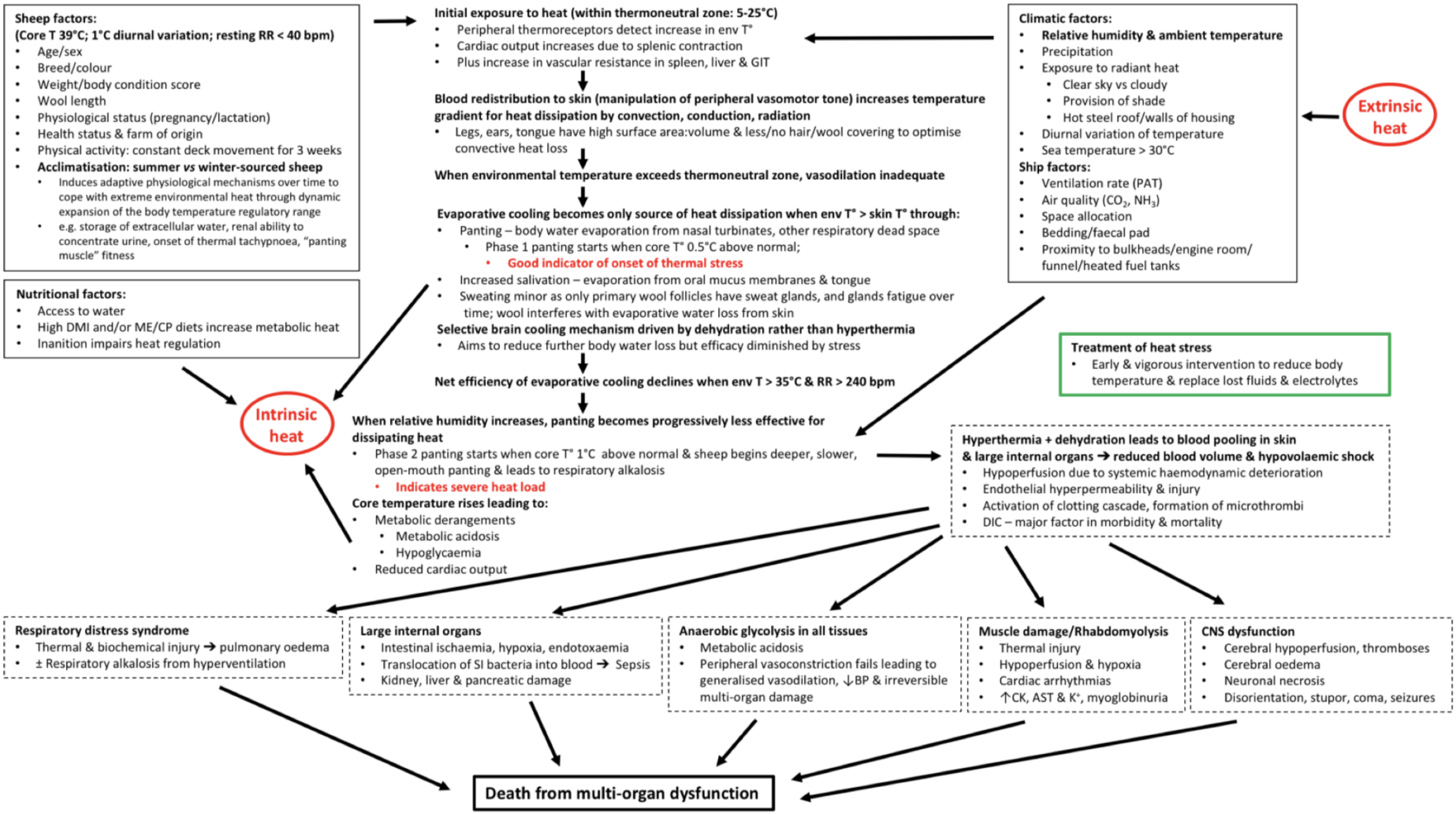

Figure 1. Pathogenesis of heat stress in sheep (sourced from http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/australian-veterinary-association.pdf).

Comment 2

The effects of a hot environment and the level of heat load that can be tolerated by sheep depend on a range of biological factors, individual variation, duration of exposure, and external stressors.

The HotStuff Panel states that it is possible to "*use measurement of standard physiological responses to determine how the animals are being affected by the heat … Assessment of the animals' respiratory rate and character are very useful for those animals which use respiratory means to lose heat*"[3]. As such, the HotStuff Panel has defined panting score and character in **Table 1**.

Table 1. Panting score and character as defined by the HotStuff Panel (sourced from https://haveyoursay.agriculture.gov.au/39528/documents/95066).

Panting score	Description	Respiratory Rate (breaths per minute)
0	Normal resting respiratory / active	40–60
1	Increased respiratory rate	61–80
2	Further increased respiratory rate accompanied by increased breathing effort, the whole animal works harder to breathe and body movements are obvious	81–120
3	Mouth open panting	121–192
4	Mouth open and tongue protruding as they pant	>192

Dr Michael McCarthy and the AVA have also defined heat stress parameters in **Tables 2 and 3** respectively.

Table 2. The McCarthy Review's method to define the effects of heat stress in sheep (sourced from http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/mccarthy-report.pdf).

Heat Stress Score	Panting Score	Respiratory Rate (RR)	Respiratory Character	Appearance or demeanour	Extrapolated percentage of ML within the HSRA model
0—Normal	0—Normal	25–80	Normal	Normal	0
1—Elevated respiratory rate	1—Normal (elevated RR)	80–100	Increased RR	Normal	0–35
2—Heat affected	2—Mild panting	100–160	Rapid RR	Discomfort	36–75
3—Onset of heat stress	3—Open mouth panting	160–220	Laboured	Extreme discomfort	76–85
4—Severe heat stress	4—Open mouth panting with tongue out	Usually second stage	Extremely laboured	Distressed	86–100

Table 3. The AVA's proposed method to define the effects of heat stress in sheep (sourced from http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/australian-veterinary-association.pdf).

Heat Stress Score (Heat Stress Threshold/HST*)	Panting Score & Respiratory character	Respiratory Rate (RR)	Approximate body temperature (°C)	Extrapolated percentage of ML within the HSRA model
0—Normal resting→active	0—Normal respiration resting→active	15–35→70	39	0
1—Mild heat stress (HST 1)	1—Increased respiratory rate	70–100	39.5+	0–35
2—Moderate heat stress (HST 2)	2—Panting	100–160	40+	36–75
3—Severe heat stress (HST 3)	3—Open mouth panting; laboured respiration	160–220	40.5+	76–85
4—Near death	4—Open mouth panting with tongue out; Extremely laboured respiration	Usually second stage	41+	86–100

[3] Source: https://haveyoursay.agriculture.gov.au/39528/documents/95066

From the tables above, it is clear that all parties agree that respiratory rate and character are useful to assess heat stress in sheep. Open-mouthed panting is not acceptable for extended periods because of the physiological impacts of cumulative heat load and the inability to shed this heat load overnight.

The AVA supports the respiratory rate ranges provided by McCarthy (**Table 2**). We suggest improvements on the Heat Stress Score descriptors in order to make them clearer and to indicate the progressive change in heat stress (**Tables 3 and 4**).

A simplified table would be the most useful for training lay operators and the AVA proposes the option below (**Table 4)**. Respiratory rates and rectal temperatures are provided for veterinary use and veterinary training manuals.

Table 4. The AVA's proposed simplified method using clear language to define the effects of heat stress in sheep, to assist training all parties in the live export chain.

HSRA Terminology	Panting Score	Breathing condition	Respiratory Rate (RR)	Approx Body Temp (°C)
At rest/activity	0	Normal to increased respiration, no panting	15–35 (→70 if active)	39
Mild heat stress	1	Mild panting, mouth closed	70–100	39.5+
Moderate heat stress	2	Fast & laboured panting; mouth closed	100–160	40+
Severe heat stress	3	Open-mouth panting	160–220	40.5+
Near death	4	Open-mouth panting/gasping, tongue out	Usually second stage	41+

Comment 3

The heat stress threshold (HST) is the point at which sheep will start open-mouth breathing, and beyond which welfare issues will unequivocally arise. The wet bulb temperature (WBT) HST for any particular class of sheep is dependent on breed, age, body condition, body weight, fleece cover, site of sourcing (zone) and month of sourcing in Australia. [For zoning see (Maunsell-Australia 2003)].

The HotStuff Panel has defined the HST in a 56 kg adult Merino wether with body condition score 3, sourced from zone 3, winter acclimatised and recently shorn, as 28°C WBT, based on the seminal heat-room studies of Catherine Stockman performed 15 years ago (Stockman 2006). The wet bulb temperature HSTs for other classes of sheep are also described in HotStuff (Maunsell-Australia 2003) and examples are given elsewhere[4].

The HotStuff Panel discusses the prediction of the HST WBT by the HotStuff Model using:

1. The predicted *ambient/bridge WBT*, gleaned from:
    a. historical meteorological data, and
    b. climate model predictions in the weeks leading up to any particular voyage, and
2. The *deck* WBT, where the following factors must be considered during future data collection and subsequent calculations:
    a. the estimated 2-4°C rise in WBT across any deck between ventilation inlets and outlets (**Figure 2**)
    b. location of thermometer/s on the deck
    c. time of reading of the thermometer (hottest part of the day *versus* an hour convenient to crew and/or maritime safety reporting requirements),

to determine whether shipping will proceed imminently or be postponed until weather is cooler, depending on whether HST will be met or exceeded.

If the ambient/bridge WBT is at or above the calculated HST for a particular class of sheep, no amount of ventilation improvement or increase in space allocation will reduce heat stress in that class of sheep. Even when the ambient/bridge temperature is 2-4°C WBT lower than the HST, various sections of any deck will likely reach or exceed the HST. The 2-4°C WBT difference between ambient/bridge WBT and deck WBT was clearly demonstrated in Figures 14-18 and 20 in the AVA submission to the HotStuff Issues Paper[4].

[4] Source: http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/australian-veterinary-association.pdf

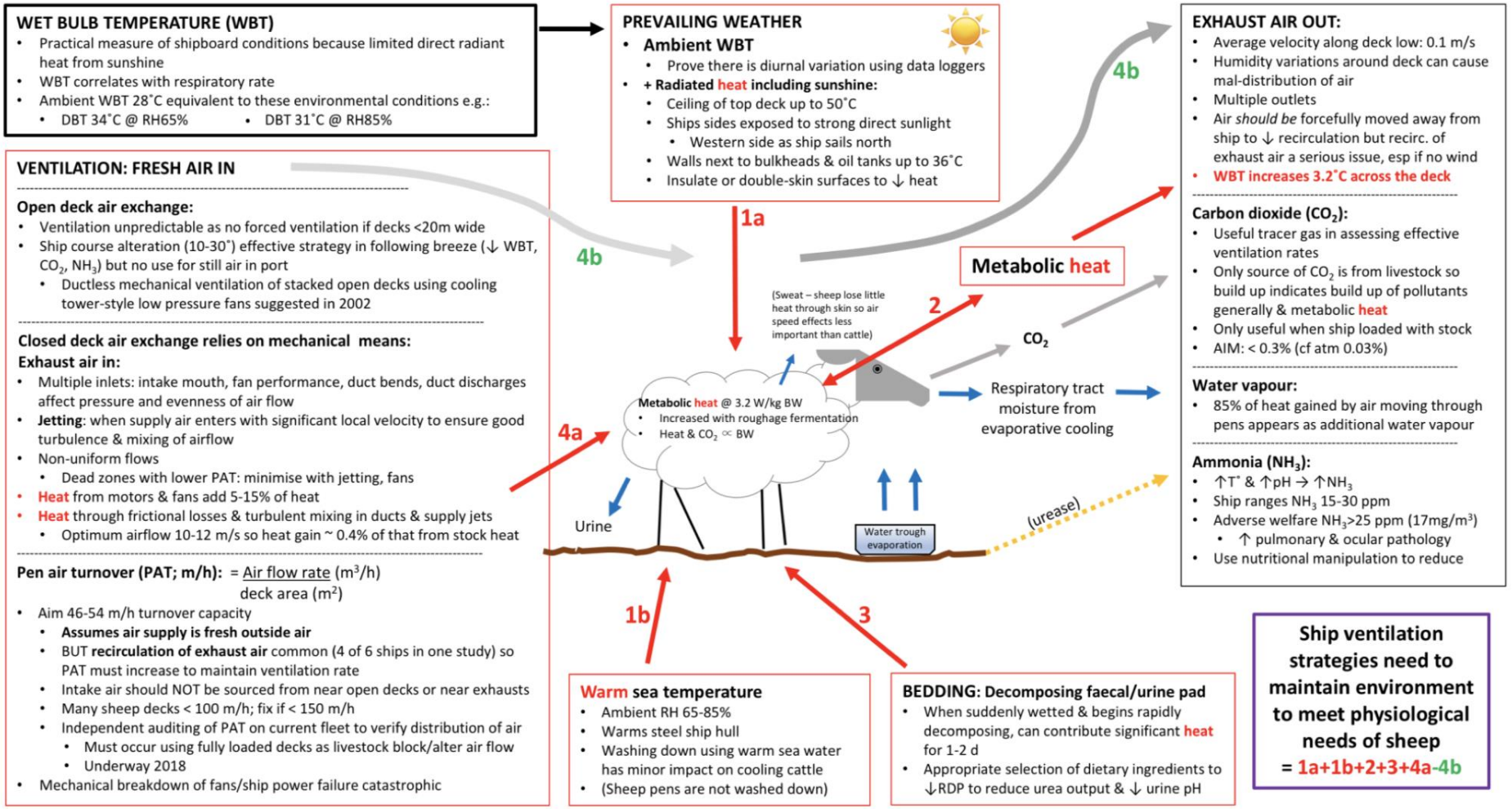

Figure 2. Sheep, ship and environmental factors that contribute to wet bulb rise across the deck of a ship (taken from http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/australian-veterinary-association.pdf).

The acceptable duration of exposure to heat stress for any class of sheep must be clearly defined during revision of the HotStuff Model.

1. The controlled studies of Stockman (Stockman 2006) in small numbers of sheep, and on-board observations (Maunsell-Australia 2003, Maunsell-Australia 2004, Stacey 2006) in larger numbers of sheep, demonstrate the physiological variation amongst different sheep within the same class in response to increasing heat and humidity. For example, during one voyage in July 2016, the first heat-related death was recorded 3 days after the onset of hot and humid weather conditions, and on day 14, 3000 sheep died (Figure 15 of the AVA submission to HSRA Issues Paper[5]).

2. Wet bulb temperatures have historically only been recorded on each ship deck from a single, easily accessible location mid-morning, once daily. This amount of data clearly does not demonstrate variation in WBT across the deck (influenced by variation in ventilation and stocking rates across the deck) nor across the day and overnight (diurnal variation on decks and ability for sheep to shed heat load on ships remains unknown). Current technology allows regular (every 10, 30 or 60 minutes), automatic measurements of WBT (e.g. Kestrel Drop D2AG Livestock Heat Stress Monitor; https://kestrelmeters.com/products/kestrel-drop-d2-livestock-heat-stress-monitor). Devices such as these should be installed at multiple locations across decks to identify WBT variation across decks and across the day.

3. Panting scores in sheep must also be recorded across decks and across each day to evaluate onset of, severity and recovery from heat stress. It is possible to install CCTV (Barnes and Stockman 2008) to perform this function.

It is recommended that physiological responses of sheep to WBT during up-coming voyages (March-April 2019) should be used to determine acceptable duration of exposure to heat stress for all classes of sheep.

Until such time that there is peer-reviewed evidence to indicate otherwise, the AVA recommends that sheep should never be exposed to HST 3, even for short periods. Sheep should not be exposed to HST 2 for more than 3 consecutive days where there is inadequate diurnal temperature variation to allow them to return to their thermoneutral zone and for respiratory rates to return to resting range at night. Otherwise, sheep can start dying within 3 days of being exposed to hot, humid weather, as heat load is cumulative. This duration of permissible exposure should be further reduced in the presence of other stressors and/or co-morbidities, as these will further reduce the animals' ability to cope.

[5] Source: http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/australian-veterinary-association.pdf

References

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2. Maunsell-Australia (2003). Development of a heat stress risk management model. Live Export Project LIVE.116, Meat & Livestock Australia.
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5. Stockman, C. (2006). The physiological and behavioural responses of sheep exposed to heat load within intensive sheep industries. Doctor of Philosophy, Murdoch University.